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THE DEVELOPMENT OF THE IRRIGATION SYSTEM OF EGYPT

By W. L. Westermann

Egyptian Pharaonic annals running back into the First Dynasty show that measurements of the rise of the Nile were kept even in the earliest period of the United Kingdom.[1] Breasted's hesitation in accepting the figures in these early annals as referring to the Nile rise[2] is based upon the fact that the measurements include fractions of a finger breadth, while no fractions appear in the extant readings from the Graeco-Egyptian Nilometers. If fractions of a "finger" can be used at all in the early dynasties—and they were used—certainly they can be employed in indicating the rise of the Nile as well as for any other purpose. Furthermore, the similarity of the terms used in the Nilometer readings of the Roman period with the terms of measurement found in the early annals should conclusively prove that the latter indicate the Nile rise of that year. The measurements which appear in the early annals recorded upon the Palermo Stone[3] are in cubits, spans, palms, and fingers. The Nile rise of the Roman period is recorded in cubits, palms, and fingers. It is true that in the few completely preserved lines of the Greek Nilometer readings out of the Ptolemaic and Roman periods, no fractions of "fingers" appear. This must be explained either as the accident of preservation or on the ground that the fractional measurement in fingers was found in the later period to be useless and was therefore abandoned.

These early notations of the height of the Nile do not prove that an irrigation system, except of the simplest sort, was in operation before the Pyramid Age. The digging of canals and the construc-

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[1] J. H. Breasted, *Ancient Records of Egypt* (Chicago, 1906), I, 57–60.

[2] *Ibid.*, I, 54, and note.

[3] πή(χεις), παλ(ασταί), δάκτυλοι. L. Borchardt, "Nilmesser und Nilstandsmarken," p. 20, in *Abhand. Preuss. Akad.*, 1906. Borchardt, p. 3, accepts the measurements of the Pharaonic annals without question as those of the Nile rise, "*so genau wie möglich . . . . gemessen und aufgezeichnet.*"

[Classical Philology XIV, April, 1919] 158

tion of dikes on a large and organized scale are not to be expected until bronze tools were used.[1] The ability to build the pyramids would warrant the conclusion that the primitive and unregulated methods of using the flood waters must have been abandoned in the Pyramid Age. The Pharaohs had then the power to organize the labor of Egypt and concentrate it upon a large enterprise. Furthermore, technical skill had been advancing rapidly and was already highly developed, as the pyramid construction attests. One is not surprised, therefore, that the word for "canals" is found in the Pyramid Texts, which fall approximately in the years 2625 to 2475 B.C.[2] In the identification in these texts of the dead Pharaoh Pepi I with Osiris, Osiris is regarded as the source of the Nile flood: "The lakes fill, the canals are inundated by the purification that came forth from Osiris."[3] An inscription of the noble Uni found in his tomb at Abydos comes from the Sixth Dynasty, or twenty-sixth century B.C. In it Uni records among the offices which he had held "that of superintendent of the irrigated lands of the Pharaoh."[4] Under the Heracleopolite rulers of the Ninth and Tenth Dynasties (2445–2160 B.C.)[5] the irrigation system must have been already highly organized, with large dikes and extensive canals. Kheti II, nomarch of the Siut nome in Central Egypt, built through arable land a canal of ten cubits (about seventeen feet—width, undoubtedly). This canal supplied water to a city in the "highland district," flooded the ancient landmarks, and covered the agricultural land with water.[6] This was clearly a large irrigation ditch. The scattered data given above warrant only the following general conclusion: The beginning of the Nile irrigation system, in the sense of a great, organized, and unified method of controlling the inundation for irrigation purposes, falls in the third millennium (the Pyramid Age and the feudal period of Egyptian history).

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[1] I have been unable to trace to its source the statement of Rev. James Baikie, in his *Egypt under the Pharaohs*, p. 21, that a "commander of the inundation" is already mentioned under Zer, the successor to Menes. The existence of an officer with this title would not, in any case, affect the opinion given above.

[2] Breasted, *Religion and Thought in Ancient Egypt* (New York, 1912), p. 85.

[3] *Ibid.*, p. 19. Cf. p. 88, where we read of a "herdman wading the canal immersed to his middle." The Pyramid Texts are available to me only in the excerpts translated by Professor Breasted in the above-mentioned work.

[4] *Records of the Past* (2d series), II, 6.

[5] For the dating see Breasted, *History of Egypt* (New York, 1905), p. 598.

[6] Breasted, *Ancient Records*, I, sec. 407.

In the Middle Kingdom references to dikes and canals become more frequent and definite. A papyrus of about 2000 B.C. tells us: "Those who build of granite . . . . who erect pyramids . . . . their offering tables are as empty as those of the weary ones (the serfs) who die upon the dikes."[1] At about the same time Khnum-hotep, a noble, was appointed administrator of the Eastern Desert by Amenemhet I. Among his duties were the regulation of boundaries between the cities of his nome, "establishing the landmarks as heaven; reckoning the waters according to that which was in the writings, apportioning according to that which was in antiquity."[2] Evidently the administrator of a nome had supervision over the irrigation in that nome. The apportionment of the irrigation waters to the various districts of the nome was, in this period, already fixed in written records which had the traditional support of long-established custom.

In the Middle Kingdom (Twelfth Dynasty) falls also the large irrigation project which brought the Fayum under cultivation. Herodotus' belief was that the depression in which Lake Moeris lay was an artificial excavation with the primary purpose of receiving the overflow of the Nile and acting as a regulator of the inundation from that place northward to the sea.[3] This information, accepted by Herodotus, is undoubtedly wrong,[4] and the formation of the Fayum is to be explained from geological evidence as a result of the action of nature.[5] The irrigation project of the Twelfth Dynasty, the first large enterprise of which we have definite information, seems to have been one of reclamation. To Amenemhat III is ascribed the construction of a great embankment within the Fayum, restricting the size of Lake Moeris and thus reclaiming the land laid bare. To accomplish this some type of regulator, or lock dam, must have been constructed at the natural entrance into the Fayum, which made it possible to exclude any further inflow after the water in the Fayum had reached a certain height. This dam might be used equally well to control the outflow from the Fayum and bring about a more continuous and regular distribution of the water of the flood time into the Delta.[1] In other words, Lake Moeris became a reservoir for the Delta for some time after the usual decline of the Nile.

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[1] From the conversation which a man weary of life holds with his own soul. "Gespräch eines Lebensmueden mit seiner Seele," Ad. Erman, *Abhand. der königl. Preuss. Akademie*, 1896.

[2] Percy E. Newberry, *Archaeological Survey of Egypt, Beni Hasan*, Part I (London, 1893), p. 59. Cf. the inscription of Khnum-hotep in *Records of the Past* (1st series), XII, 17.

[3] Herod. ii. 149.

[4] Major R. H. Brown, *The Fayûm and Lake Moeris* (London, 1892), pp. 19, 25–26.

[5] *Ibid.*, pp. 61–69.

In the period of the Egyptian Empire further progress in the development of the system is indicated in the sources. It is especially marked in the administrative organization.

In the reign of Thothmes III the oversight of the water supply of entire Egypt was centralized in the hands of the vizier of Egypt. The vizier had a corps of officials working under his direction in this department.[2] After the reign of Thothmes III the importance of the irrigation system is accentuated in the inscriptions and Pharaonic papyri by reference to various canals with distinctive names, notably "the Water-of-Re" or the "western canal" in the Delta.[3] In the Papyrus Harris, Rameses III recites among his benefactions in a prayer to Re: "I made slaves as watchmen of the canal-administration."[4] This must refer to the appointment of slaves as guards upon the embankments at the time of the flood, possibly with oversight of the corvée labor of the peasants during that period. If this is true, the statement indicates a highly developed organization of the whole system of irrigation for this period.

In the Twenty-first Dynasty, under a Sheshonk whom Breasted is inclined to regard as Sheshonk I, 945–924 B.C.,[5] we find an official with the title "chief of irrigation."[6] In the fifth century Herodotus of Halicarnassus visited Egypt. He was not sufficiently impressed with the irrigation system itself to enumerate it among the wonders of the country. Lake Moeris alone, because of its size and because of his belief that it was "hand-made," attracted his attention; and he gives us some information about this reservoir which is very difficult to interpret.[1]

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[1] *Ibid.*, pp. 69–70. Grenfell, Hunt, Hogarth, *Fayum Towns and Their Papyri* (P. Fay.) (London, 1900), pp. 4–5.

[2] Breasted, *Ancient Records*, II, sec. 698.

[3] *Ibid.*, IV, sec. 224, and note *d.* Cf. the Heliopolitan canal of IV, secs. 266, 278, 394.

[4] *Ibid.*, sec. 266.

[5] *Ibid.*, IV, 359.

[6] *Ibid.*, IV, sec. 726.

These scattered bits of information are what we have left out of the period of some 2,600 years during which irrigation in the Nile Valley was gradually evolving into the effective system which existed when Egypt was assigned as a satrapy to Ptolemy Lagus in 323 B.C.

Several important periods of development or of restoration of the irrigation system appear in the Ptolemaic and Roman periods. Under Ptolemy Philadelphus occurred the reclamation of an additional tract of land in the Fayum which was incorporated in the royal domain. This was done by again lowering the level of Lake Moeris, thus diminishing its size and bringing above water and beyond the water level another portion of the former lake bed.[2] The evidence of this is from geographic data. Also the archaeological remains found in this region of the Fayum do not in any case antedate the reign of Philadelphus.[3]

In support of this testimony comes positive documentary evidence of the digging of new canals and the construction of new dikes in the Fayum. The period covered from the beginning to the completion of this project is approximately 270–237 B.C.[4] The Petrie Papyri furnish us some correspondence out of the archives of two of the *architectones*, or chief engineers, in charge of the Arsenoite nome, who superintended the work of construction. The first of these, Cleon, was chief engineer (ἀρχιτέκτων) certainly from 258 to 252 B.C. In 255 a subengineer (ὑπαρχιτέκτων) named Petechonsis was working under him. An official document which falls somewhere between 251–247 B.C. announces the advance of a man named

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[1] Herod. ii. 149. Cf. P. Fay., p. 8.

[2] P. Fay., p. 15. Mahaffy's suggestion that the irrigation system of Egypt was neglected by the Persian rulers (P. Pet. II, 13) may, on general principles, be true; but the reclamation work of the early Ptolemies does not *necessitate* this as a conclusion.

[3] P. Fay., p. 15.

[4] Westermann, "Land Reclamation in the Fayum under Ptolemies Philadelphus and Euergetes I," *Classical Philology*, XII, 429–30.

Theodorus from the position of subengineer to that of chief engineer. It is clear from the correspondence of Cleon with his family that he fell into disfavor with the king, Ptolemy Philadelphus, at some time in the years 251–247 B.C. and was displaced by his subordinate, Theodorus. Theodorus remains *architecton* ("chief engineer") from that time to 237 B.C. It is probable that the work was completed and the office abolished in that year or shortly thereafter.[1]

The next large enterprise in connection with the irrigation system was a thorough cleansing of the canals occurring a few years after Augustus occupied Egypt. The direction of this work is to be ascribed to Aelius Gallus, second Roman prefect of Egypt, in the years 27–25 B.C. Possibly its beginning falls under the first prefect, Cornelius Gallus, which would stretch the period to 28–25 B.C.[2]

There is no other great organization which has left a trace in the literature until we come to the time of the emperor Probus. He too, as Augustus had done, used the soldiery in his work of amelioration in Egypt.[3] Vopiscus tells us that he did so much work upon the Nile that by his efforts alone he increased the revenue in grain; that he built bridges, opened up many mouths of rivers (?), dried several swamps, and established crops and arable land where the swamps had been. This is the same type of work which was done by Aelius Gallus during his prefecture of Egypt and described in detail by Strabo (xvi. 1. 9, 10) when dealing with the Babylonian lowlands. The mouths of the canals were cleaned out and a greater volume of the overflow diverted for the use of the lands of Middle and Upper Egypt. The inundation throughout Egypt, and especially in the Delta, was thereby better regulated. Hence arable land was gained in regions which remained swampy under a neglected system. The "bridges" mentioned by Vopiscus are evidently those spanning the canals. The restoration and building of these is a marked feature of the work of the Ptolemaic irrigation engineers, Cleon and Theodorus, in the Petrie Papyri.

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[1] For the chronology of this enterprise see the article just cited, *Classical Philology*, XII, 426–30.

[2] Westermann, "Aelius Gallus and the Reorganization of the Irrigation System of Egypt under Augustus," *Classical Philology*, XII (July, 1917), 237–43.

[3] Vopiscus, *Vita Probi*, 9. 3, in *Historiae Augustae Scriptores*.

It is impossible to determine exactly the date of the work of Probus in Egypt.[1] It may have been done under his direction when he was holding command in the east,[2] or under his orders after he became emperor. In the latter case the work is ascribed to the emperor as that conducted by Aelius Gallus was ascribed by Suetonius to Augustus. In any event this reorganization is to be placed somewhere in the decade 270–80 of our era.[3] It was evidently an attempt to check the decline in production from the responsive soil of Egypt which has always so amply repaid any labor expended upon it. This decline began in the third century.[4] In the fourth century the irrigation system had unquestionably lost greatly in efficiency. The ditches which carried water to the fields around Bacchias, Philadelphia, and Euhemeria had filled up, and the towns themselves were abandoned.[5] These were the Greek towns which had sprung up around the edge of the Fayum upon land reclaimed for irrigation by the *architectones* Cleon and Theodorus. Competent engineering and an effective system of irrigation had given them hard upon 600 years of life. The decline of this system gave them back to the desert.

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[1] J. H. E. Crees, *The Reign of the Emperor Probus* (London: University of London Press, 1911), p. 154.

[2] *Ibid.*, p. 90.

[3] Crees is unable to agree with Lépaulle in assigning the work of Probus in Egypt to 280–81. See Crees, *op. cit.*, p. 154.

[4] P. Fay., Introduction, p. 16.

[5] *Ibid.*, pp. 16 and 45.